draft working paper for peer review only

Pollock

2019 Assessment Update Report

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

Compiled September 2019

This assessment of the pollock (Pollachius virens) stock is an update of the existing 2017 operational assessment (NEFSC 2017). This assessment updates commercial and recreational fishery catch data, research survey indices of abundance, the ASAP analytical models, and biological reference points through 2018. Additionally, stock projections have been updated through 2022. In what follows, there are two population assessment models brought forward from the 2017 operational assessment: the base model (dome-shaped survey selectivity), which is used to provide management advice; and the flat sel sensitivity model (flat-topped survey selectivity), which is included for the sole purpose of demonstrating the sensitivity of assessment results to survey selectivity assumptions. The most recent benchmark assessment of the pollock stock was in 2010 as part of the 50th Stock Assessment Review Committee (SARC 50; NEFSC 2010), which includes a full description of the model formulations.

State of Stock: The pollock (*Pollachius virens*) stock is not overfished and overfishing is not occurring (Figures 1-2). Retrospective adjustments were made to the model results. Retrospective adjusted spawning stock biomass (SSB) in 2018 was estimated to be 212,416 (mt) under the base model and 71,322 (mt) under the flat sel sensitivity model which is 170 and 101% (respectively) of the biomass target, an SSB_{MSY} proxy of SSB at $F_{40\%}$ (124,639 and 70,721 (mt); Figure 1). Retrospective adjusted 2018 age 5 to 7 average fishing mortality (F) was estimated to be 0.038 under the base model and 0.094 under the flat sel sensitivity model, which is 14 and 36% (respectively) of the overfishing threshold, an F_{MSY} proxy of $F_{40\%}$ (0.272 and 0.26; Figure 2).

Table 1: Catch and status table for pollock. All weights are in (mt), recruitment is in (000s), and F_{AVG} is the age 5 to 7 average F. Unadjusted SSB and F estimates are reported. Model results are from the current base model and flat sel sensitivity model.

	2011	2012	2013	2014	2015	2016	2017	2018
Data								
Commercial landings	7,211	6,742	5,058	4,545	3,043	2,582	3,249	3,078
Commercial discards	176	121	169	135	155	97	49	70
Recreational landings	3,447	1,355	4,078	1,511	752	1,030	1,239	687
Recreational discards	2,958	2,151	4,123	2,441	2,190	1,522	2,059	944
Catch for Assessment	13,792	10,370	13,428	8,632	6,139	5,231	6,597	4,779
Model Results (base)								
Spawning Stock Biomass	234383	208817	196520	184110	208798	221237	250282	276305
F_{AVG}	0.136	0.108	0.157	0.108	0.068	0.048	0.044	0.027
Recruits $age1$	29695	51121	50567	75056	49903	36034	32358	24169
Model Results (flat sel sensitivity)								
Spawning Stock Biomass	88172	76164	70252	62825	73521	84802	100368	112633
F_{AVG}	0.279	0.231	0.366	0.261	0.163	0.11	0.098	0.058
Recruits $age1$	16057	27367	27264	40406	27095	19710	17940	13950

Table 2: Comparison of biological reference points for pollock estimated in the 2017 assessment and from the current base model and flat sel sensitivity model. An F_{MSY} proxy of $F_{40\%}$ was used for the overfishing threshold, and was based on yield per recruit analysis. F_{MSY} is reported as the age 5 to 7 average F. Recruits represent the median of the predicted recruits. Intervals shown are 5^{th} and 95^{th} percentiles.

	2017 base	2017 flat sel sensitivity	base	flat sel sensitivity
F_{MSY}	0.260	0.249	0.272	0.260
SSB_{MSY} (mt)	105,510	60,738	124,639 (98,701 - 158,416)	70,721 (55,964 - 89,609)
MSY (mt)	19,427	11,692	19,856 (14,471 - 27,709)	12,007 (8,876 - 16,407)
Median recruits (age 1) (000s)	22,183	13,067	25,312	14,503
Overfishing	No	No	No	No
Overfished	No	No	No	No

Projections: Short term projections of median total fishery yield and spawning stock biomass for pollock were conducted based on a harvest scenario of fishing at an F_{MSY} proxy of $F_{40\%}$ between 2020 and 2022. Catch in 2019 has been estimated at 5,140 (mt). Recruitments were sampled from a cumulative distribution function derived from ASAP estimated age 1 recruitment between 1970 and 2016. Recruitments in 2017 and 2018 were not included due to uncertainty in those estimates. The annual fishery selectivity, natural mortality, maturity ogive, and mean weights used in projections are the most recent 5 year averages. Retrospective adjusted age 5 to 7 average F in 2018 fell outside the 90% confidence intervals of the unadjusted 2018 value under the base model (Figure 2). Retrospective adjusted SSB and age 5 to 7 average F in 2018 fell outside the 90% confidence intervals of the unadjusted 2018 values under the flat sel sensitivity model (Figures 1-2). Therefore, age-specific abundance rho values were applied to the initial numbers at age in the projections for the base model and the flat sel sensitivity model.

Table 3: Retrospective adjusted short term projections of median total fishery yield and spawning stock biomass for pollock from the current base model and flat sel sensitivity model based on a harvest scenario of fishing at an F_{MSY} proxy of $F_{40\%}$ between 2020 and 2022. Catch in 2019 has been estimated at 5,140 (mt). F_{AVG} is the age 5 to 7 average F.

Year	Catch (mt)	SSB (mt)	F_{AVG}	Catch (mt)	SSB (mt)	F_{AVG}
		base			*flat sel sensitivity*	
2019	5,140	190,927	0.036	5,140	65,237	0.092

Year	Catch (mt)	SSB (mt)	F_{AVG}	Catch (mt)	SSB (mt)	F_{AVG}
		base			*flat sel sensitivity*	
2020	35,358	200,992	0.272	14,522	69,808	0.260
2021	26,765	176,117	0.272	11,924	63,273	0.260
2022	19,889	160,156	0.272	9,388	59,921	0.260

Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass, F, recruitment, and population projections).

  One of the greatest sources of uncertainty in the pollock assessment is selectivity, as the base model with dome-shaped survey and fishery selectivities implies the existence of a large cryptic biomass that neither current surveys nor the fishery can confirm. Assuming that survey selectivity is flat-topped leads to lower estimates of SSB and higher estimates of F (Figures 1-2). Stock status is insensitive to the shape of the survey selectivity patterns at older ages. Another source of uncertainty is the major retrospective pattern (see Question 2). In addition, the strength of the 2013 year class is a source of uncertainty in short term stock projections. For both models, the 2013 year class is estimated to be smaller in size than in the previous assessment, but it is still estimated to be the largest year class in the assessment time series, 1970-2018. The 2013 year class has begun to enter the commercial fishery, and uncertainty in the year class' strength should decrease as it moves through the fishery in subsequent years.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted SSB or F_{AVG} lies outside of the approximate joint confidence region for SSB and F_{AVG}; see Table **??**).

  The 7-year Mohn's ρ, relative to SSB, was 0.231 under the base model and 0.407 under the flat sel sensitivity model in the 2017 assessment and was 0.301 and 0.579, respectively, in 2018. The 7-year Mohn's ρ, relative to F, was -0.278 under the base model and -0.35 under the flat sel sensitivity model in the 2017 assessment and was -0.282 and -0.389, respectively, in 2018. There was a major retrospective pattern for the base model because the ρ adjusted estimate of 2018 F (F_ρ=0.038) was outside the approximate 90% confidence region around F (0.019-0.035). There was a major retrospective pattern for the flat sel sensitivity model because the ρ adjusted estimates of 2018 SSB (SSB_ρ=71,322 (mt)) and 2018 F (F_ρ=0.094) were outside the approximate 90% confidence region around SSB (83,067-142,199 (mt)) and F (0.042-0.073). A retrospective adjustment was made for both the determination of stock status and for projections of catch in 2020. The base model retrospective adjustment changed the 2018 SSB from 276,305 (mt) to 212,416 (mt) and the 2018 F_{AVG} from 0.027 to 0.038. The flat sel sensitivity model retrospective adjustment changed the 2018 SSB from 112,633 (mt) to 71,322 (mt) and the 2018 F_{AVG} from 0.058 to 0.094.

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

  Population projections for pollock appear to be reasonably well determined for both the base model and the flat sel sensitivity model. The stock is not in a rebuilding plan.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the affect these changes had on the assessment and stock status.

  Two changes were made to the pollock assessment as part of this update. First, the new calibrated recreational catch estimates were used in the assessment. The new recreational catch estimates are greater than the old estimates, particularly at the beginning and end of the time series, 1981-2018. In both models, the new recreational catch estimates may contribute to the increased scaling of SSB compared to SSB estimates from the previous *assessment, which used the old recreational catch estimates. Second, evaluation of the commercial age composition residuals led to the inclusion of a new commercial selectivity time block, beginning in 2010. In both models, the new time block improved the residual patterns, and led to an increased scaling of SSB compared to runs without the new time block. This rescaling of SSB likely is due to the difficulty that both models have in scaling the stock size (see Question 8). In addition to these two changes, the impact of survey stratum 1300 not being sampled in the 2018 fall bottom trawl survey was explored. No adjustments were made to the 2018 fall survey index value, because stratum 1300 makes up an average of only 1% of the expanded survey catch in numbers over the entire time series, 1970-2018, and only 3% of the expanded survey catch in numbers in recent years, 2009-2018. In the 2019 assessment of pollock, the catch efficiency studies and data were not used because studies were not focused on this species.*

- If the stock status has changed a lot since the previous assessment, explain why this occurred.

  Stock status based on the base and flat sel sensitivity models has not changed since the previous assessment.

- Provide qualitative statements describing the condition of the stock that relate to stock status.

  Total removals of pollock have declined since 2013. The spring survey index increased from 2013 to 2018, before decreasing in 2019. The fall survey index has decreased since 2014. Fishery and survey data suggest the exisitence of a relatively strong 2013 year class, which has just begun to enter the commercial fishery. Survey data suggests that older fish have begun to reappear in the stock since the 1990s.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

  The pollock assessment could be improved with additional studies on gear selectivity. These studies could cover topics such as physical selectivity (e.g., multi-mesh gillnet), behavior (e.g., swimming endurance, escape behavior), geographic and vertical distribution by size and age, tag-recovery at size and age, and evaluating information on length-specific selectivity at older ages.

- Are there other important issues?

  As in the previous assessment, both of the pollock assessment models had difficulty converging on a solution in some of the retrospective peels and jitter analysis runs. One possible explanation for this issue is that the models may be overparameterized, with the base and flat sel sensitivity models estimating 223 and 221 parameters, respectively. The high number of parameters is due to the fact that the commercial and recreational fisheries are modeled as separate fleets. The effects of combining the two fleets into a single fleet should be explored during the next benchmark assessment. In addition, both of the models have a tendency to rescale the population size when years of data are dropped or added to the assessment, while the relative trends in stock size over time remain the same. This difficulty in scaling the stock may be tied to the convergence issue.

References:

Northeast Fisheries Science Center. 2010. 50^{th} Northeast Regional Stock Assessment Workshop

(50^{th} SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 10-17; 844 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. CRD10-17

Northeast Fisheries Science Center. 2017. Operational Assessment of 19 Northeast Groundfish Stocks, Updated Through 2016. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 17-17; 259 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. CRD17-17

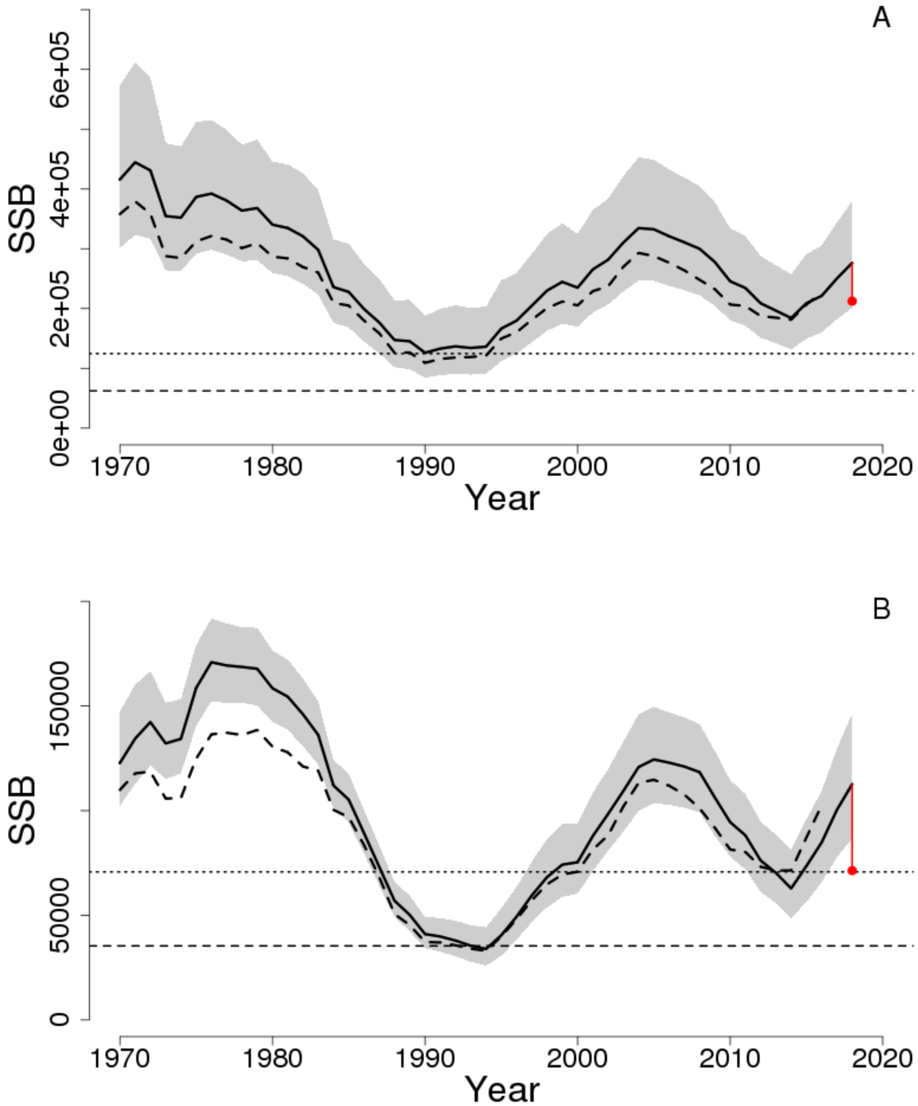


Figure 1: Estimated trends in the spawning stock biomass of pollock between 1970 and 2018 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 * SSB_{MSY} proxy; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} proxy; horizontal dotted line) based on the 2019 assessment models base (A) and flat sel sensitivity (B). Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

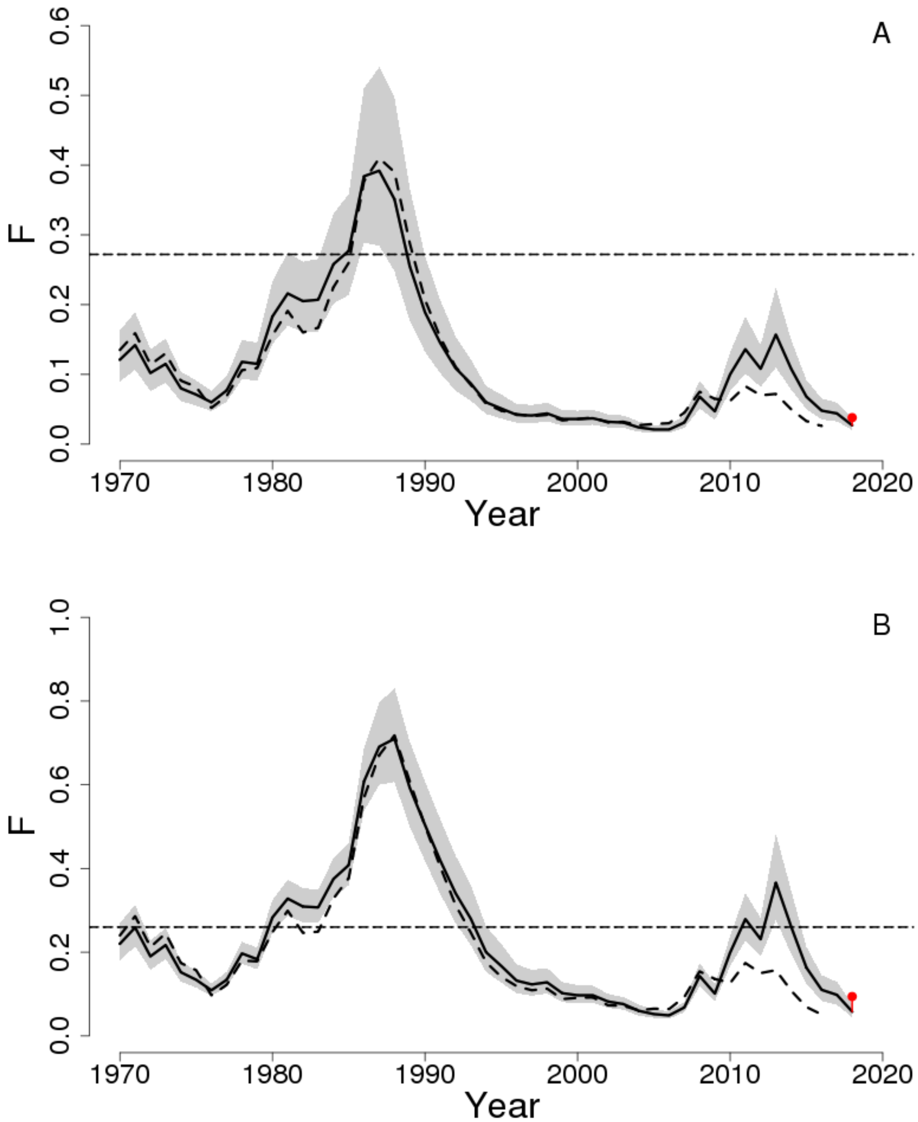
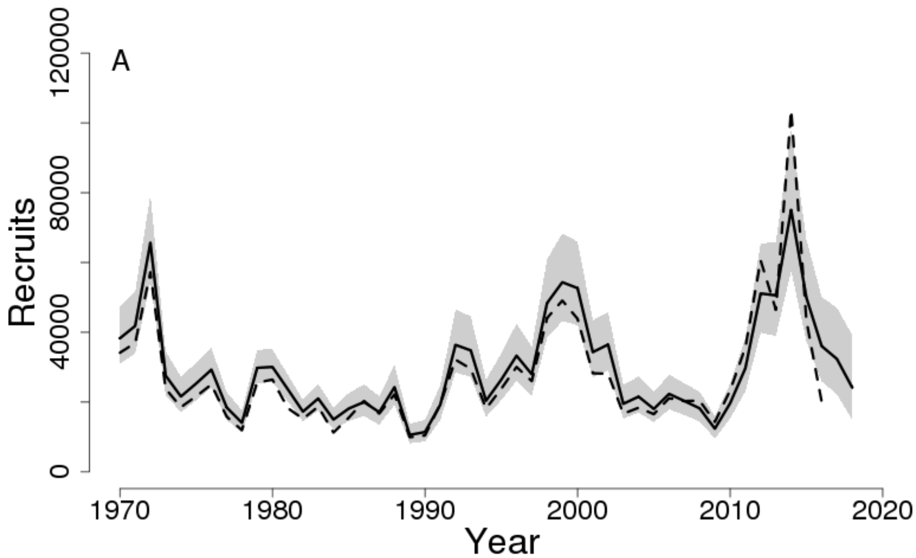


Figure 2: Estimated trends in age 5 to 7 average F (F_{AVG}) of pollock between 1970 and 2018 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} proxy; dashed line) based on the 2019 assessment models base (A) and flat sel sensitivity (B). F_{AVG} was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.



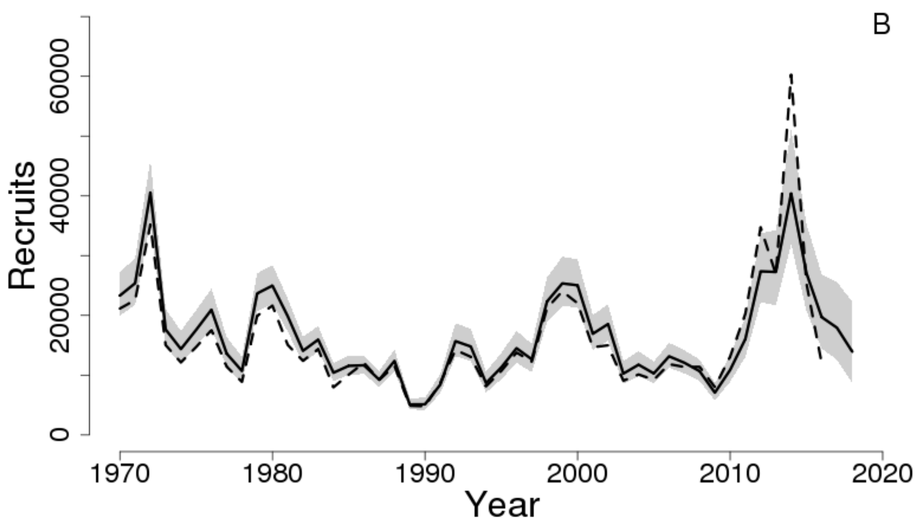


Figure 3: Estimated trends in age 1 recruitment (000s) of pollock between 1970 and 2018 from the current (solid line) and previous (dashed line) assessment for the assessment models base (A) and flat sel sensitivity (B). The approximate 90% lognormal confidence intervals are shown.

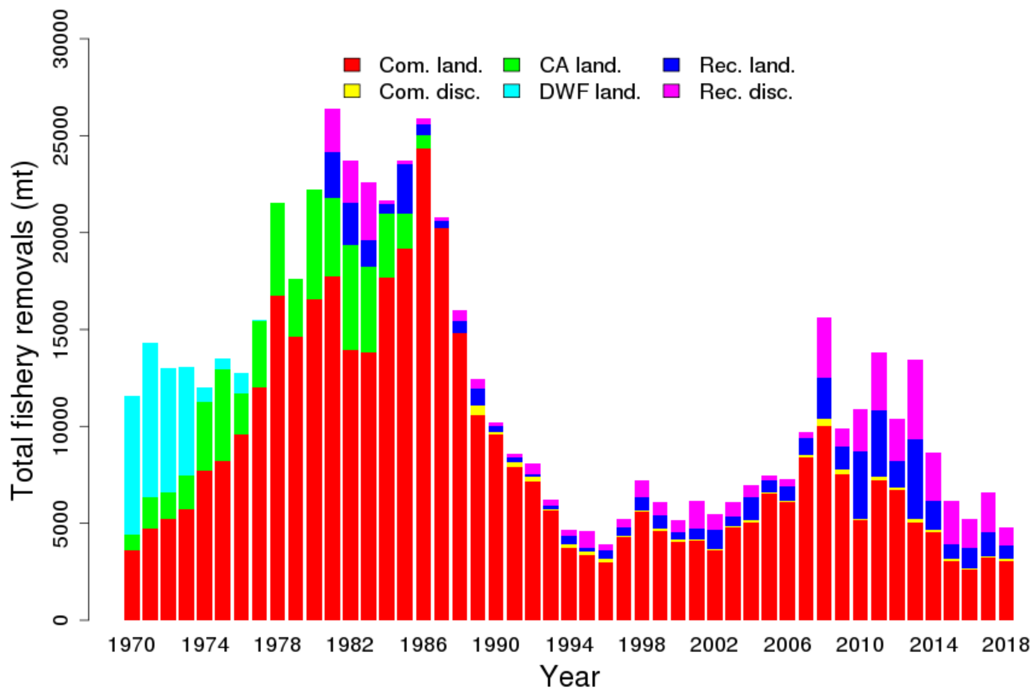


Figure 4: Total catch of pollock between 1970 and 2018 by fleet (commercial, Canadian, distant water fleet, and recreational) and disposition (landings and discards).

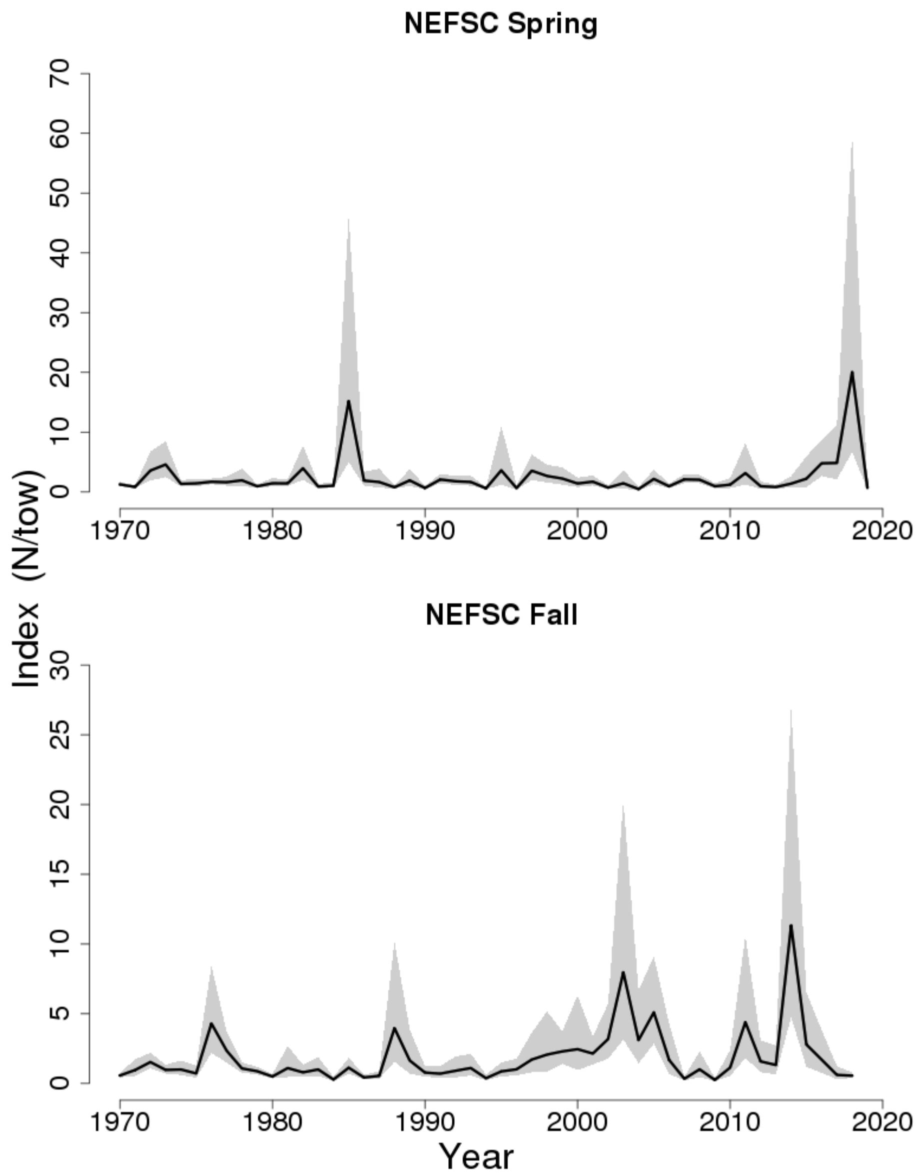


Figure 5: Indices of abundance for pollock from the Northeast Fisheries Science Center (NEFSC) spring (1970 to 2019) and fall (1970 to 2018) bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.